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USE OF ANTIOXIDANT TO INHIBIT BROWNING ON WHITE PEPPER DECORTICATING PROCESS

NANAN NURDJANNAH

Indonesian Center for Agriculture Postharvest Researh and Development
Jalan Tentara Pelajar No.12, Bogor, 16111

ABSTRACT

White pepper is an important export commodity for Indonesia, until 2003 about 70 percent of word demand of white pepper was supplied by Indonesia, but it dropped to about 40 percent in 2004. White pepper processing is still done at farm level using a very modest method. The process consists of soaking the berries for seven to twelve days, followed by pepper skin separation and drying the pepper corn for three to five days. The product is often contaminated by undesirable microorganism, and also unpleasant odor which is caused by improper method and limited clean water for soaking process. Researh Institute for Spice and Medicinal Crops under Agriculture Department has designed and constructed the pepper thresher and decorticating machine to improve the product quality and process efficiency. Those machines could produce the hygienic white pepper with high essential oil content, however it has brownish white color caused by browning process during decorticating process. The consumer used to white pepper with creamy white in color. The antioxidants, malic and tartaric acids were applied to prevent the browning process. The treatment consisted of three factors, i.e.: kind of antioxidant (malic and tartaric acid), antioxidant consentration (1.5, 2,0 and 2,5 percent) and soaking period (1, 2 and 3 hrs). The experiment was arranged in Completely Randomized Design with two replications. The result showed that both acids could be used as antioxidant to inhibit browning in pepper mechanical decorticating process. The colour of white pepper produce was creamy white similar to the one produced by traditional method. The optimum treatment was malic acid with 2.5 percent concentration and 2 hours soaking period.

Key words : Pepper, *Piper nigrum* L., processing, traditional, mechanical, antioxidan, white pepper

ABSTRAK

Penggunaan antioksidan untuk mencegah proses pen-cokelatan pada proses pengupasan kulit lada

Lada putih adalah salah satu komoditas ekspor penting bagi Indonesia, dimana sampai tahun 2003 kurang lebih 70 persen kebutuhan dunia dipenuhi oleh Indonesia. Namun pada tahun 2004 jumlah tersebut turun drastis menjadi kurang lebih 40 persen. Pengolahan lada putih masih dilakukan di tingkat petani dengan peralatan yang sangat sederhana yang prosesnya terdiri dari perendaman selama tujuh sampai duabelas hari, diikuti dengan pemisahan kulit dan pengeringan biji lada selama tiga sampai lima hari. Lada putih yang dihasilkan sering terkontaminasi oleh mikroorganisme yang tidak diinginkan dan juga mempunyai bau busuk akibat dari metode yang kurang baik dan keterbatasan air bersih. Balai Penelitian Tanaman Rempah dan Obat telah berhasil merancang bangun alat perontok dan pengupas lada untuk meningkatkan mutu lada dan efisiensi prosesnya. Dengan mesin tersebut dapat diproduksi lada putih higienis dengan kadar minyak atsiri yang tinggi, namun warnanya kecokelatan yang disebabkan karena proses pencokelatan yang terjadi selama proses pengupasan kulit. Sedangkan konsumen biasa dengan warna yang putih kekuningan. Penggunaan antioksidan (asam malat dan tartrat) untuk mencegah proses pencokelatan tersebut telah dicobakan. Perlakuan terdiri dari : jenis antioksidan (asam malat dan tartrat), konsentrasi antioksidan (1,5; 2,0 dan 2,5 persen) serta lama perendaman (1, 2 dan 3 jam). Percobaan dirancang secara acak lengkap dengan ulangan dua kali. Hasil percobaan menunjukkan bahwa asam malat dan asam tartrat dapat digunakan untuk mencegah proses pencokelatan pada proses pengupasan kulit lada dengan mesin. Warna dari lada putih yang dihasilkan putih kekuningan sama dengan yang dihasilkan dengan cara tradisional (perendaman). Perlakuan terbaik adalah penggunaan asam malat pada konsentrasi 2,5 persen dengan waktu perendaman dua jam.

Kata kunci : Lada, *Piper nigrum* L., prosesing, tradisional, mekanik, antioksidan, lada putih

INTRODUCTION

White pepper is an important export commodity for Indonesia, until 2003 about 70 persent of world demand is supplied by Indonesia, but it dropped in 2004 to about 40. At present, the white pepper process is still done at farm level with unadequate equipment. The process consists of soaking the berries for seven to tweleve days, followed by pepper skin separation and drying the seed for three to five days (NURDJANNAH and DHALIMI, 1998). This method sometimes produces white pepper which is contaminated by undesirable microorganism, and also rotten odor because of improper processing method and limited of clean water. Besides, it has relatively low essential oil content because of long period of soaking. The process itself is not efficient because of long period of soaking process, whereas to get good quality of white pepper plenty amount of clean water is needed. White pepper produced by farmer is usually reprocessed by exporter before it is exported to meet the consumer quality standard, by this way only the exporter and middlemen get the added value. Sometime Indonesian white pepper is detained by FDA (Food and Drug Administration) because of undesireble microbial contain such *Esschericia coli* and *Salmonella* and low essential oil content. In order to improve the farmer income and to improve the bargaining power at the world market, it is desirable to improve the processing method at farm level.

Research Institute for Spice and Medicinal Crops under Agriculture Department has designed and constructed white pepper processing machines consisted of thresher, decorticator and dryer. The process does not need as much water as the traditional one, its processing time is much shorter, it produces hygenic white pepper with higher essential oil content and natural flavor. However, its color is brownish white which is not undesirable to be served in the whole form. In powder form (grinded), it is similar to the one produced by traditional method (soaking process) (RISFAHERI *et al.,* 1992).

The browning process on white pepper process happened at decorticating process. MUCHTADI (1992) stated that pepper berries contained tannin component which was easily solved in water and the color of pepper seed became brownish to dark brown when it was exposed to the oxygen. According to IYENGAR and EVILY (1992), browning was exacerbated by tissue damage, caused by cutting, peeling, communicating, pureeing, pitting, pulping or freezing. In uncut or undamaged fruits and vegetables, the phenolic substrates are separated from polyphenol oxidation (PPO) by compartmentalization, and the browning does not occur. MANGALAKUMARI *et al*. (1983) also stated that the blackening is a polyphenolase catalysed reaction.

The enzymatic reaction on fruit and vegetables only happened on the fresh tissue or in the tissue contain active phenol oxidation enzyme. When the enzyme is already denaturated by heat or other treatment such as the addition of chemical substance, the enzymatic reaction will not happen (MEYER, 1982). According to ESKIN (1990), the inhibition process of enzymatic browning is the inhibiting of the action of polyphenol oxydase on phenolic coumpound and oxygen, and the inhibitor has to have the characteristics as follows : does not change the texture and flavor of the product, non toxic, and not expensive. Moreover IYENGAR and EVILY (1992) stated that antioxidant agents have been classified according to the primary mechanism of action, there are reducing agent, chelating agent, acidulants, PPO inhibitors, complexing agent, enzyme treatment and combination of anti browning agents.

Acidulant is used to control pH. The optimum pH value of PPO activity varies with the source of enzyme and the nature of the substrate. In most cases, it is in the pH range of six to seven, and the enzyme is inactive in pH below four. Hence, the role of acidulants is to maintain the pH well below that necessary for optimal catalytic activity (IYENGAR and EVILY, 1992).

Since polyphenol oxidase is a metalloprotein in which copper is the prosthetic group, it is inhibited by a variety of chelating agents (ESKIN, 1990). Chelating agent is a food additive which could bind the copper which is loose from its complex in the food during cooking process, and it could accelerate the oxidation process (rancidity in oil and fat), and brwoning (FACHRUDDIN, 1998). IYENGAR and EVILY (1992) stated that chaleting agent could bind the copper on the active site and make it holoenzyme.

The browning reaction is the changes of fenolic compound to quinon, and its process depends on the availability of phenolase enzyme, copper and oxygen (ESKIN *et al.,*1971). Phenolase acts as a catalyst in oxidation reaction, copper acts as an electron transferer and oxygen act as an electron acceptor.

The use of chelating agent as additive in food product is to help stabilizing its color, taste and texture (FACHRUDDIN, 1998). The chelating agents are carboxyl acid (oxalate, suxinate), hidroxyl acid (lactic, malic , citric and tartaric acid), polyphosphor acid (ATP, piro-phosphate), amino acid, petide, and protein (BELITZ and GROSCH, 1999).

The most widely used acid in food industry for prevention of browning is citric acid. It may have dual inhibitory effect on PPO ; lowering of the pH and chelating the copper at the active site of enzyme. The alternative to citric acid are organic acids such as malic, tartaric and malonic acids, and inorganic acids such as phosphoric and hydrochloric acids.

Tartaric acid is transparant white crystal, odorless, non toxic, stable and dissolve in water, ether and alcohol (ARSYAD, 2001). The acid is usually added to candy, juice, ice cream and baking powder because of its capability as a chelating agent and also acts as a synergist with other antioxidants (BELITZ and GROSCH, 1999).

Malic acid is a colorless crystal, easily solved in water and alcohol and slightly solved in ether (HOWLEY, 1971). This acid could act as an acidulant in the food substrate as well as citric acid (HUI, 1992). According to BELITTZ and GROSCH (1999), malic acid is used in jam, jelly and healthy drink as a chelating agent which could make a complex with metal so that the oxidation reaction could be prevented. DL-malic is permitted to be used in the food and beverage with the maximum limit of 110 mg/kg weight (FAO/WHO, 1967 *in* BRANEN *et al,* 1990).

The obyective of this experiment is to find out the possibility of using malic and tartaric acid to inhibit browning reaction in mechanical decorticating process of white pepper. Furthermore, it is also to find out the optimum concentration and method of application.

MATERIAL AND METHODS

Material and Equipments

The experiment was done at Research Institute for Spice and Medicinal Crops, Bogor, on July to September 2002.

The fresh pepper berries were obtained from farmer garden at Serang, West Java, Indonesia which were picked at 8 to 9 months after flowering. Malic acid and tartaric acid as antioxidants were obtained from chemical store. Other material used were chemicals for analysis of pepper berries and dried white pepper.

Equipments used were pepper thresher, decorticator and equipments for the analysis of water content, essential oil content, and whiteness value.

Methodology

The experiment consisted of two steps :

I. Preliminary Experiment

The preliminary experiment consisted of some activities :

- Analysis of component in fresh pepper berries and white pepper resulted by mechanical process. It covered the water, essential oil, starch, protein, vitamin C, fat and sugar content.
- Preparing several concentration of malic and tartaric acid solution with the pH value less then 3.0, the concentration were : 0.1, 0.5, 1.0, 1.5, 2.0, 2.5, and 3.0
- Pepper kernel which was decorticated by decorticating machine was devided by 14 and each parts were soaked in each concentration acids mentioned above for one hour. Afterwards the peeled kernel (pepper corn) were sundried to get dried white pepper. The characteristic of dried white pepper were observed, which is covered : whiteness value, acid content, essential oil content and water content. The characteristics of dried white pepper was then compared to the one pruduced by traditional method.
- The process of traditional method consists of ; soaking the berries in water for 8 days, with changes of water every 2days and then peeled and sundried. In this case 8 days of soaking process was enough because after 8 days soaking the skin was already soft and could be removed from the corn.

The (1.5, 2.0 and 2.5 %) acid concentrations were applied on mechanical process produced white pepper with "whiteness value" similar to the one processed by traditional method (soaking process), and the above acid concentration were chosen to be applied in the main experiment (see table 2 and 3).

II. Main Experiment

In the main experiment white pepper was processed using mechanical process with acid treatment right after decorticating process. The diagram of the process can be seen in Figure 2.

The treatments applied on the main experiment were :

A = antioxidants	: A1 = Malic acid
	A2 = Tartaric acid
B = Acid Concentration	: B1 = 1.5 %
	B2 = 2.0 %
	B3 = 2.5 %
C = Soaking period	: C1 = 1 hr
	C2 = 2 hrs
	C3 = 3 hrs

Observation was done on the characteristics of white pepper produced, covering whiteness value, total acid content, essential oil content, and water content. Whiteness value was analysed using "whiteness meter", total acid content by titration method, essential oil content by distillation method and water content using aufhauser apparatus.

The traditional method of white pepper production and mechanical process whithout acid treatment were also done and the characteristics of the products were used to be compared with the characteristics of white pepper produced by mechanical process with acid/antioxidant treatment. The diagram of white pepper process using traditional method can be seen in Figure 1.

Pepper berries + stalks

↓

Soaking in water
(8days)

↓

Skin separation and washing

↓

Pepper corn

↓

Drying (cemented floor)

↓

Dried white pepper

Figure 1. The diagram of traditional white pepper processing method
Gambar 1. Diagram alir pengolahan lada putih secara tradisional

Pepper berries + stalks

↓

Threshing (thresher)

↓

Pepper berries

↓

Decorticating (decorticator)

↓

Skin separation and washing

↓

Pepper corn → Soaking in water (1 hr)

↓

Soaking in malic or tartaric acid (1,2 and 3 hrs)

↓

Drying (sundrying)

↓

Dried White Pepper

Figure 2. The diagram of white pepper mechanical process
Gambar 2. Diagram pengolahan lada putih secara mekanis

The experiment was arranged in Completely Randomized Design, factorially with two replications. If one or all treatments applied showed a significant influence on the parameters observed, to find out the significant effect between treatments, the DMRT (Duncan Multiple Range Test) was done on 5 percent level.

RESULT AND DISCUSSIONS

Preliminary Experiment

Fresh pepper berries contain vitamin C (Acorbic acid) about 0.30 percent and total acid about 0.31, means that most of the acid in the pepper berries is ascorbic acid (Tabel.1) . The acid content decreased after pepper berries processed into white pepper because during soaking process some of the acid solved in the water. Vitamin C is easily dissolved in water.

The result of preliminary experiment showed that the higher the acid (antioxidant) concentration , the higher the whiteness value and the acid content of dried white pepper produced. The 1.5, 2.0 and 2.5 percent acid concentrations produced white pepper with the whiteness value closed to the one produced by traditional method, however they had higher acid content (Table 2, 3 and 4). It was proved that by lowering the pH of the pepper tissue could reduce or retard the development of enzymatic browning (ESKIN, 1990).

Table 2 and 3 also show that essential oil content of white pepper treated with different concentrations of antioxidant were relatively the same, and were higher than the one produced by tradiotional method (Table 4). Based on these results, the above concentrations of antioxidant were applied in the main experiment.

Table 1. The components of fresh pepper berries and dried white pepper
Tabel 1. Komponen dari buah lada segar dan lada putih kering

Component (%) *Komponen (%)*	Fresh berries *Buah lada segar*	Dried white pepper *Lada putih kering*
Water *Air*	64.15	8.12
Ess.oil *Minyak atsiri*	1.64	3.68
Acid *Asam*	0.31	0.13
Starch *Pati*	18.32	32.35
Protein *Protein*	4.73	13.50
Vit.C *Vit. C*	0.30	0.14
Fat *Lemak*	1.72	4.94
Sugar *Gula*	2.72	7.27

Table 2. The relationship between tartaric acid concentration and the characteristics of white pepper
Tabel 2. Hubungan antara konsentrasi asam tartrat dengan karakteristik lada putih

Antioxidant *Antioksidan*	Dried white pepper *Lada putih kering*				
Conc.(%) *Konsentrasi* (%)	pH value *Nilai pH*	Whiteness value (%) *Derajat keputihan*	Acid content (%) *Kadar asam (%)*	Essential oil content (%) *Kdr minyak atsiri (%)*	Water content (%) *Kadar air (%)*
0.1	2.64	14.48	0.16	3.47	6.81
0.5	2.24	14.93	0.18	3.11	5.96
1.0	2.06	15.08	0.19	2.58	10.20
1.5	1.95	15.38	0.20	3.34	6.90
2.0	1.84	15.58	0.21	3.23	7.26
2.5	1.78	15.80	0.22	3.31	8.41
3.0	1.57	17.20	0.23	3.34	7.19

Table 3. The relationship between malic acid concentration and the characteristics of white pepper
Tabel 3. Hubungan antara konsentrasi asam malat dengan karakteristik lada putih

Antioxidant *Antioksidan*	Dried white pepper *Lada putih kering*				
Conc. (%) *Konsentrasi (%)*	pH value *Nilai pH*	Whiteness value *Derajat keputihan*	Acid content (%) *Kadar asam (%)*	Essential oil content (%) Kdr. Minyak atsiri (%)	Water content (%) *Kadar air (%)*
0.1	2.71	13.88	0.14	3.45	8.52
0.5	2.38	14.50	0.15	3.25	9.51
1.0	2.23	15.03	0.16	3.32	7.83
1.5	2.11	15.18	0.16	2.85	8.95
2.0	2.02	15.65	0.17	3.12	7.73
2.5	1.96	16.23	0.21	3.24	8.82
3.0	1.75	18.10	0.22	3.66	6.80

Table 4. The characteristics of white pepper produced by traditional method and mechanical method without acid application
Tabel 4. Karakteristik lada putih yang dihasilkan dengan cara tradisioanal dan cara mekanis tanpa perlakuan asam

Sample *Contoh*	Whiteness value (%) *Derajat keputihan (%)*	Acid content (%) *Kadar asam (%)*	Ess. Oil content (%) *Kadar M. Atsiri (%)*	Water content (%) Kadar air (%)
K	11.6	0.13	3.11	8.73
T	15.7	0.11	2.49	6.97

Note : K = Mechanical method, T = Traditional method
Keterangan : K = Cara mekanis, T = Cara tradisional

Main Experiment

The Analysis of Variance showed that kind of antioxidant (malic and tartaric acid) did not give significant influence on the characteristics of white pepper produced from all treatments, however the concentration of antioxidant gave a significant influence on the whiteness value, and soaking period gave significant influence on whiteness value and acid content. There was no significant influence on the interaction between treatments applied.

Whiteness Value

Whiteness value is the important factor of white pepper which will determine the quality of white pepper. The good quality (Quality I) of white pepper should have creamy white color (SNI 01-0004-1987).

The whiteness value of white pepper treated with malic and tartaric acid were relatively the same, there was no significant difference, both gave the high whiteness value. The 2.5 percent antioxidant concentration gave the highest whiteness value, however it was not significantly difference with 2.0 percent acid concentration (Table 5). The 1.5 percent concentration gave the lowest whiteness value and significantly different with the 2.0 and 2.5 percent concenrations (Table 5). This is because of the higher the antioxidant (acid) concentration, the lower the pH value (Table 3 and 4), far below the optimum pH (6 to 7) for polyphenol enzyme activity, so that the development of enzymatic browning was retarded.

MEYER (1982) stated that pH value influenced the speed of browning reaction. Reaction speed went slow on the low pH value. In relation to the above reason, the use of malic and tartaric acid could reduce the speed of the reaction and on certain pH value the reaction would stop at all. According to BELITTZ and GROSCH (1999), besides lowering the pH, malic and tartaric acid could also act as a chelating agent for copper, so that the oxidation process on polyphenol could be inhibited. Copper is a co-factor needed for oxidation reaction, the release of copper from polyphenol enzyme caused the enzyme inactive.

The longer the soaking period the higher the whiteness value of white pepper (Tabel 5). This is because of the longer soaking process gave the opportunity for the acid (antioxidant) to be contacted with pepper seeds longer, so that the browning inhibiting reaction more complete. The whiteness value of white pepper resulted from mechanical process with antioxidant soaking treatment was very much higher than the one resulted without antioxidant treatment, and it was similar to the one resulted from traditional method. It means that the malic and tartaric acid were effective antioxidants to prevent browning process on pepper mechanical decorticating process.

White pepper resulted from mechanical process with water soaking treatment has the same whiteness value with the one resulted from mechanical process without water soaking treatment (Table 5). It showed that water was not effective to inhibit browning process, because it could only prevent the corn in contact with oxygen temporarily (only during soaking process), and the pepper corn directly contacted with the oxygen after water draining. The enzymatic browning process which is an oxidative reaction, could be prevented by eliminating the oxygen. It could be was done by soaking the stuff in sugar or salt solution. This method is not always easy because the browning process will occur when it is exposed again to the oxygen (HUI, 1992 and IYENGAR and EVILY, 1992).

Acid content

The duration of antioxidant soaking process significantly influenced the acid content of white pepper produced (Table 6). The longer the soaking period, the higher the acid content. It means that more acid was absorbed by white pepper product. However, the result of organoleptic test showed that even the longest soaking period (3 hrs) did not give any significant effect on the flavor of white pepper (there was no acid taste).

White pepper resulted with traditional method had the lowest acid content (K3=0.09%), followed by mechanical process with water soaking treatment (K1=0.11%), and mechanical process without soaking treatment (K2=0.13%) (Table 6). On the traditional method, the pepper berries were soaked in the water for 8 days with the water changes every 2 days. For that reason some of the acid was possibly solved in the soaking water.

Table 5. The influence of antioxidant concentration and soaking period on the whiteness value of white pepper
Tabel 5. Pengaruh konsentrasi antioksidan dan waktu perendaman terhadap derajat keputihan dari lada putih

Code *Simbol*	Treatment *Perlakuan*	Whiteness value (%) *Derajat keputihan* (%)
B	Antioxidant concentration (%) *Konsentrasi antioksidan (%)*	
	B1 : 1.5	18.62a
	B2 :2.0	18.67b
	B3 : 2.5	19.62b
C	Soaking period (hr) *Waktu perendaman (hr)*	
	C1 : 1	16.25a
	C2 : 2	18.92ab
	C3 : 3	19.61b
K	Control *Kontrol*	
	K1	11.69
	K2	11.60
	K3	20.45

Note : K1 = mechanical process, 1 hr water soaking before drying
Keterangan : cara mekanis, 1 jam perendaman seblm pengeringan
K2 = mechanical process, whithout soaking treatment
cara mekanis, tanpa perlakuan perendaman
K3 = traditional method, 8 days soaking period
cara tradisional, perendaman selama 8 hari

Table 6. The influence of soaking period on the acid content of white pepper produced
Tabel 6. Pengaruh waktu perendaman terhadap kadar asam dari lada putih yang dihasilkan

Code *Kode*	Treatment *Perlakuan*	Acid content (%) *Kadar asam (%)*
C	Antioxidant soaking period (hr) *Waktu perendaman dg antioksidan* (%)	
	C1 : 1	0.15 c
	C2 : 2	0.17 b
	C3 : 3	0.21 a
K	Control *Kontrol*	
	K1 : mechanical, 1 hr water soaking process *cara mekanis, dg 1 hr perendaman*	0.11
	K2 : mechanical, without soaking process *cara mekanis, tanpa perendaman*	0.13
	K3 : Traditional method, 8 days soaking *cara tradisional, 8 hari perendaman*	0.09

Note : Number followed by the same letter in the same column is not significantly different at 5%
Keterangan : Angka yang diikuti huruf yang sama pada kolom yang sama tidak berbeda nyata pada taraf 5%

The acid losses on white pepper resulted from mechanical process with water soaking treatment (K1) was less than the one resulted from traditional method (K3) because the contact duration between pepper berries with water on mechanical process (1 hr) was shorter than the contact duration on traditional method (8 days). The highest acid content was on white pepper produced by mechanical process without any soaking treatment (Table 1). The loss of acid during soaking process is because of most acid in pepper berries was ascorbic acid (vit C) which is easily dissolved in water (SCHULER, 1996)

Essential Oil Content

The essential oil content is an important factor to determine the quality of pepper products including white pepper which determines its flavour value. The treatments applied did not give any significant influence on the essential oil content of white pepper produced by mechanical process. The essential oil content of white pepper produced by mechanical process (3.61 – 3.98 %) was higher than the one produced by traditional method (2.49 %) (Table 4). This is because on traditional method pepper berries was soaked in water for 8 days with the water changes every two days, which caused part of essential oil washed out.

Water Content

The water content of food stuffs during storage is very important because the development of insect, microorganism and food spoilage are very influenced by the availability of water in it. Pepper water content under 12 percent could maintain the quality of pepper during storage. However, the temperature and humidity (Rh) of the storage place are also important factors which influence the water content and enzyme activity of the product. Water content of white pepper produced in the main experiment ranged between 7 to 9 percent and none of the treatments applied gave significant influence on the water content of white pepper produced.

Optimum Combination Treatment

Malic and tartaric acid did not give significant difference on the whiteness value of white pepper produced. However, the price of tartaric acid (Rp 125,000/kg) was much more higher than the price of malic acid (Rp 25,000/kg). For that reason the use of malic acid is more recommended than tartaric acid.

Whiteness value of white pepper was influenced by acid concentration treatment. However there was no significant difference between whiteness value of white pepper resulted with 2.0 percent and 2.5 percent acid percentation treatments. Since white pepper produced with 2.5 percent acid treatment had the whiteness value (19.62%) closer to the one produced by traditional method (20.45%), the 2.5 percent acid is recommended to be applied.

The three hours acid soaking period produced white pepper with the highest whiteness value, but its acid value was relatively high (0.21%), however there was no significant difference between the one produced with one and two hours soaking treatments (Table 5 and 6). For that reason the use of 3 hours soaking period is not recomended because of its high acid content and the relatively long period of acid soaking process.

Based on the above reasons, combination treatments recommended is mechanical process with the use of 2.5 percent malic acid as antioxidant and two hrs soaking period. The characteristic of white pepper produced was as followed : 18.19 percent whiteness value. 0.17 percent acid content and 3.83 percent essential oil content. The one hour soaking period can be recommended also to reduce the soaking period since the whiteness of white pepper produced was almost the same (Table 5).

CONCLUSIONS

Mechanical process could be used to produce high quality of pepper with antioxidant treatment to prevent the oxidation reaction during decorticating process. Malic and tartaric acids were the effective antioxidants to inhibit browning reaction on the pepper mechanical decorticating process. The whiteness value of pepper of mechanical process is relatively the same with the one produced by traditional method. Moreover, it has higher essential oil content and natural pepper flavour.

The optimum combination treatment recommended is 2.5 percent malic acid as antioxidant with 2 hours soaking period. However, the storage experiment is needed to find out the stability of whiteness value.

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